DESCRIPTION

METHOD AND APPARATUS FOR CONTROL OF A WRITE SIGNAL IN AN OPTICAL DISC SYSTEM

The present invention relates to a method and apparatus for the control of a write signal, in particular, for use within an optical disc system.

Optical disc technology has developed from initial CD formats to more recent DVD formats requiring ever more accurate and readily controllable optical write devices based upon laser technology.

In order to further enhance the control of the laser source, it has been known to develop feedback signals in order to tune the laser power dynamically during recording onto an optical writable, and/or re-writable disk. Such feedback serves to enhance the quality of the recorded signal irrespective of any local variations in optical characteristics of the surface of the disc arising, for example, from fingerprints, dots and/or scratches on the surface of the disc. Through the use of such feedback signals the write quality can be maintained at a relatively consistent level.

In such known systems, the feedback signal is generally derived and calculated on the basis of measurement of the absorption area of the RF signal for discs comprising dye media, or RF signals sampled between writing pulses for discs comprising phase-change media.

The feedback signal can itself be normalised on the reflection signal when seeking to measure the absorption area, or indeed on the laser power signal as derived from the signal returning from the disc and offering an indication of the reflection measurement.

While such known feedback arrangements have proved advantageous in relation to optical discs employing CD writable and re-writable technology, the analogue basis for the measurements required to arrive at the feedback signal do not support DVD writable and re-writable technologies, and in particular the new Write Strategy employed when writing to DVD media.

The present invention seeks to provide for a method and apparatus for the control of a write signal for use in an optical disc system and which has advantages over known such methods and apparatus as referred to above.

According to a first aspect of the present invention there is provided a method of controlling writing of a signal to an optical disc and including the step of generating a feedback signal to dynamically tune the source of the said signal, and further comprising the steps of generating a plurality of timing signals serving to define a plurality of sampling windows for selecting data samples from RF signals derived from the signal reflected from the disc, generating a plurality of runlength selection signals to allow for measurement of light reflection at required runlength lands or pits, and measuring light reflected at a runlength land or pit in processing means and employing the measured signal as the said feedback signal for the said tuning of the signal source.

In particular, the width and/or positions of the sampling windows can be programmable and the said RF signals are arranged to be selected when the runlength signal is high.

The sampling rate of the said RF signals advantageously is at least equal to the frequency of a system channel clock and the RF sample signals can be selected by means of the timing signals within a sample engine.

Low pass filtering the sampled signals is preferably introduced and slope and offset values can be calculated on the basis of the low pass sampled signals.

The method of the present invention advantageously employs the feedback signal for fine-tuning the Write Strategy associated with a DVD writable device.

In particular, a threshold value serving to determine which of the sampled signals initiate the said measurement can be adopted.

According to another aspect of the present invention, there is provided a write signal control apparatus arranged for controlling writing of data to an

optical disc and comprising means for generating a feedback signal for dynamically tuning the source of the said signal, means for generating a plurality of timing signals serving to define a plurality of sampling windows, means for selecting data samples for RF signals derived from a signal reflected from the disc, means for generating a plurality of runlength selection signals arranged to allow for measurement of the reflection at a runlength land or pit, and processing means for measuring the reflected signal at the runlength land or pit, wherein the said measured signal serves as the said feedback signal for tuning the said signal source.

Means can advantageously be included to provide for the advantageous further features discussed above in relation to the method of the present invention.

The invention is described further hereinafter, by way of example only, with reference to the accompanying drawings in which:

Fig. 1 is a timing diagram illustrating the relationship between writing signals and signals for developing the feedback signal within an embodiment of the present invention; and

Fig. 2 is a block diagram illustrating one embodiment of signal processing arrangement for producing the feedback signal in accordance with an embodiment of the present invention.

As will be described from the following, the present invention advantageously provides for a digital signal processing method which can offer the same functionality as that of known feedback signal processing methods but which advantageously offers further functionality so as to advantageously dynamically fine-tune the Write Strategy for recording at high speed within DVD writable and re-writable media and also to dynamically fine-tune the laser light source power during recording onto the disc.

The potential for increase in performance when writing a signal to a disc in accordance with DVD writable and re-writable specifications arising from the use of the multi-pulse modulation Write Strategy can rely on such writing and

rewriting processes employing Eight to Fourteen Modulation (EFM+) for recording and the present invention can advantageously be arranged to develop the feedback signal based upon the measurement of the temperature of the dye layer of the disc.

Particularly important aspects of an arrangement embodying the present invention are as follows.

A plurality of timing signals are generated and serve to define windows which are employed to select data samples from signals derived from the RF analogue-digital converter within the optical writing device.

The signalling is arranged such that data samples are selected when the timing signals are high and the width of each sampling window, and indeed the positions of the sampling windows, with respect of the actual laser power output signals can be advantageously programmable. Examples of such timing signals are illustrated in Fig. 1.

Referring now to Fig. 1, the waveforms 10, 12 represent the EFM+ channel clock and write signals and waveform 14 illustrates the form of the laser light output signal in accordance with the lands and pits of a disc.

Waveforms 16A-16D represent four of the aforementioned sampling windows and as determined by the aforementioned timing signals.

As mentioned, the sampling windows are programmable and different configurations are illustrated by the different waveforms 16A, 16B, 16C and 16D.

A plurality of runlength selection signals are generated and serve to allow for the measurement of the degree of reflection at a design runlength land or pit. Examples of such runlength selection signals 18A-18B are likewise illustrated in Fig. 1. When a runlength selection signal 18A or 18B is "high", the samples derived from the RF analogue-digital converter are then selected.

As illustrated by the arrows on signals 18A and 18B, the window determined by the runlength selection can comprise either the current and next runlength land or pit, or alternatively the previous and current runlength land or pit.

Since the runlength selection signal can be expressed as (N,>N) this allows for runlengths N, N+1...,....14 to be selected for a DVD system.

It should be appreciated that the sampling rate of the RF analogue-digital converter within the optical drive can be as low as the frequency of the channel clock illustrated by waveform 10.

The differences between the signals arising for writing to a CD writable dye device 20 and a DVD writable dye device are also illustrated in Fig. 1. As shown the waveform of the signal arising in accordance with the DVD Write Strategy in which the recording mark is divided into a top pulse and a serious of multiple pulses 22 is likewise illustrated.

Yet further, in view of the inherent difference in the Write Strategy employed for DVD writable and re-writable media as compared with that for dye media such as CD writable and re-writable discs, a threshold value 26 as illustrated in relation to pulse waveform 22 can be employed in addition to the window-defining timing signals 16A-16D and the runlength selection signals 18A, 18B in order to select appropriate samples from the radio frequency analogue-digital converter.

For any required absorption measurement, the sampled signals from the RF analogue-digital converter will then only be selected when the magnitude of the samples is greater than the threshold value. Of course, the level of the threshold value can be tuned dynamically within digital signal processing or hardware means at, if required, a lower rate.

The RF PC signals 24 resulting from either of the write signals 20,22 are also illustrated in relation to those write signals within Fig. 1.

As mentioned previously, measurement can be based on dye temperature since the temperature of the dye material alters its frequency response to light. With light of a fixed frequency and known power, a variation in temperature is represented as a variation in reflectivity. This reflectivity could be sampled, for example, by way of waveform 16C to determine how hot the dye is after pit formation. Since the change is relatively small, if can be averaged over a number of samples and compared with samples from waveform 16D where the temperature should have reduced. This information

can then be considered for both short and long marks and dye temperature can be determined therefrom. This information can then be used for so-called “thermally balanced write strategy” in which the thermal effect of one mark is taken into account in its neighbours. This is particularly important for high speed writing.

Turning now to Fig. 2, there is illustrated, in block diagram, a signal processing arrangement 28 for use in accordance with an embodiment of the present invention. The input signals 30 to the processing arrangement comprise the RF samples that are effectively selected by the timing signals 16A-16D in a sample engine (not shown).

The portion of the processing arrangement illustrated in Fig. 2 comprises a feedback signal accelerator block which includes low pass filters 32,34,36,38 for receiving each of respective selected binned sampled RF signals from a sample bin engine (not shown).

The low pass signals are then delivered to processor arrangements such as a digital signal processor or digital hardware 40 which serve to calculate slope and offset signals as is described further below.

The low pass signals are also delivered to a selecting unit 42 which is arranged to select one of the low pass signals for delivery to a multiplier 44 arranged to receive the aforementioned slope signal 46, and the resulting signal is output to an adder 48 arranged to receive the aforesaid offset signal 50 from the digital signal processor/digital hardware unit 40. The resulting signal from the adder 48 comprises a feedback signal 52 which, in accordance with the present invention, is employed to provide feedback control to the laser light source of the writing unit so as to seek to achieve consistent write quality irrespective of local variations in the characteristics of the disc and, in particular, in connection with DVD writable and re-writable disc.

The Write Strategy and/or the laser power employed when writing to a DVD disc can therefore advantageously be dynamically fine-tuned.